NEWSLETTER

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PROCESSING 5251 & 5254 THE RIGHT WAY

By Paul Farber

24 FORMULAS YOU CAN MIX

By Patrick Dignan

GUIDE TO COLOR PRINTING

(Reprint)

We have a number of new subscribers to the Dignan Photographic Newsletter, so for their benefit we would like to take a moment and explain not only the reason for the Newsletter, but also for Dignan Photographic.

For 30 years we have read articles about photography. They were very informative until they approached the subject of color processing. All of a sudden we ran into forbidden territory. "These solutions are impossible to mix if you do not own a laboratory stocked with an analytical balance, pH meter, titration equipment and of course, you need the secret formulas." Over the years we have collected the secret formulas and we found that like in most magic there was a few tricks involved. For instance, the first obvious rule was don't let the formulas fall into the wrong hands, the wrong hands being the photographer! Second, if you must publish the formulas in some technical journal make certain that part of the information is erroneous, and third, use either code names for the chemicals or resort to some alternate, and if possible, obscure chemical name for as many of the ingredients as possible. The above list could be extended, but I think we have made our point.

Now this philosophy (or call it what you will) has been extremely successful, so successful that most independent laboratories and photographers have a difficult time producing acceptable color.

--more--

When we say color, we are talking about color prints, transparencies, and motion picture prints. We know because many have called us for help. For instance, a recent call was from a laboratory using C-22. "Could you supply us with the pH of the various solutions used in C-22?" We answered with, "Have you talked with your Kodak representative?" The answer was, "Hell, we can't even find him". All of this, of course, is silly and in the long run has hurt rather than helped photography. It has hurt photography so badly that after three years we have only a few thousand photographers who can honestly say, "We push the button and we also do the rest".

Although we have a very impressive list of subscribers which includes advanced amateurs, independent professional photographers, companies involved in photography, photo laboratories and government agencies, the Newsletter has an extremely small distribution. We attempt to call "a spade a spade", we are not dictated to by advertisers (we carry no advertising) and we also are not wealthy.

The Newsletter does have a number of faults. It is expensive, it never contains enough information, the printing will never win a prize and invariably it is mailed late (by about 5 weeks).

The main thing to remember is that we are after the facts. We hate to say it, but in our opinion all emulsion manufacturers and particularly Kodak are hiding behind the facade of alchemy. We also think that they are backing themselves into a corner because the average photographer is terrified at the idea of even attempting color photography. We think he wants to understand it, but he keeps getting "Mickey Mouse" answers to questions that need honest answers.

For instance, why is it that so many of our subscribers who are users of the C-22 kits report that they have had better success with the Official C-22 chemistry which we publish, than they have had from the commercial Kodak C-22 kits. Or why does Kodak recommend a combination of Sodium Hydroxide and Borax in one set of formulas and Sodium Metaborate in another, when both formulas produce the same pH. We can only <u>guess</u> at the reasons and we are extremely disappointed ....in Kodak.

Perhaps every giant needs an Achilles heel. If that is one of the roles we are destined to play, then so be it! We have said before that Kodak makes the best emulsions in the world; they have done more for photography than any other company, but someone up there better start listening because we know that there is a large and growing group of <u>intelligent</u> photographers and laboratories who want the right answers. They are tired of producing mediocre results in the hope that the customer or friend will not notice that in "their" portrait they have green hair!

Why are we <u>again</u> picking on Kodak? They finally became a subscriber to the Dignan Newsletter and we think they should know why.

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INFORMATION ABOUT THIS ISSUE

Processing 5251 & 5254 - Correctly.

Paul Farber, who is an associate editor for Travel & Camera and Camera 35, also contributes to the Newsletter. He is not just a photography writer, he is a meticulous experimenter who wants all of the facts and he wants them correct. To write the enclosed article on 5251 & 5254, we know that he not only mixed and used all of the formulas in the Newsletter pertaining to the processing of this film, but he personally contacted all of the authors scattered around the country who have contributed articles to the Newsletter on this subject. We have personally discussed this subject with him at least 50 different times over the last six months.

He also discussed it with Kodak representatives and he has also talked with a number of motion picture laboratories in the Southern California area. He has done this in an effort to make 5251 & 5254 as compatible as possible with color print paper, and as you know this is difficult because basically these films are primarily manufactured to produce motion picture prints.

24 Formulas You Can Mix.

Although we distributed this article to thousands of our customers in the past, we have a feeling that it may help a number of readers who may have missed it. We are reprinting it in the hope that it may answer a number of questions that continually crop up from new subscribers.

Coming Next Month.

Official Kodak formulas for processing internegative. Also, Simplified C-22 formulas.

PROCESSING 5251 & 5254 — CORRECTLY

By: Paul Farber

Eastman Kodak's motion picture negative films, types 5251 and 5254, have been the subject of more discussion than speed increasing developers for black and white films. Unfortunately there are a number of unavoidable problems in using this film for the making of color prints. One of the problems is the fact that these films are not compatible with C-22 chemistry -- no matter what you may have read or heard (even in this redoubtable Newsletter). You must mix the basic developer from scratch, and there is no way to avoid it.

The second, and most serious problem, is the fact that these films have a low blue/yellow contrast. This is inherent in the emulsion, and no amount of over-development can compensate for this deficiency. In terms of making prints this means that some color imbalance must be accepted, and the imbalance cannot be totally corrected by filtration. In color negatives we must try to bring all three layers of film to the same relative gamma. Unfortunately the gamma of the blue/yellow layer is not alterable to the needed degree, and in printing you may find that the highlights may be filtered for clean color reproduction, but the dark shadows may have a magenta tinge. If you try to eliminate the magenta tinge in the shadows you may end up with a green/yellow cast in the highlights. This is unavoidable and must be accepted!

The reason for the low blue contrast is simple: the curve of 5251 and 5254 are matched to the curves of print release film (this is the film which is used for motion picture projection in theatres). Unfortunately print release film and color print papers do <u>not</u> have the same curves. So accept the limitations and you will have prints that are superbly fine-grained -- with slight off-color imbalance in the highlights or deep shadows. The color cast is no greater than .05 --- and this is an error which most color printers accept as nominal, even with perfect materials.

The first problem, the chemistry, can be a time-consuming problem of unavoidable depth. With this in mind I set out to compound a series of concentrated solutions which can be used as a one-shot type of developing solution. They are based on using the standard developer, SD-30, and C-22 chemistry for

the balance of the processing times. Here are my concentrates:

Concentrated SD-30 Developer

Part "A"		Dignan Catalog No.
Distilled water	100.0 cc	
Benzyl Alcohol	15.0 cc	(B200)
Diethylene Glycol	15.0 cc	(D380)
Distilled water to	200.0 cc	

Mix well, and then add:

Sodium Bisulfite	4.0 grams	(S400)
DD-3	20.0 grams	(DD-3)
Water to a total of	480.0 cc	

The mixing of Part "A" may appear strange, but simply follow the directions as given. After the solution is completely mixed, place it in a clean brown glass bottle and label it for reference.

Part "B"

Distilled water	500.0 cc	
Calgon	8.0 grams	(C150)
Sodium Sulfite (anhyd)	8.0 grams	(S790)
Potassium Bromide	4.0 grams	(P530)
Sodium Hydroxide (10% solution)	22.0 cc	not carried
Sodium Carbonate (mono.)	200.0 grams	(S500)
Distilled water to	960.0 cc	

The addition of Calgon to the solution may seem strange in view of the fact that distilled water is being used. However, specific gravity is of importance and it was also added in case the stock solutions are mixed with tap water.

To use the concentrated solutions take 145.0 cc of distilled water, add 60.0 cc of solution "B" (this is important - do not add the "A" solution first), then add 30.0 cc of solution "A". This makes a total of 235.0 cc of working developer and it will safely cover a roll of 35mm film when it is developed in a Nikor tank.

Concentrated Stop Bath

Water	500.0 cc	
Glacial Acetic Acid	75.0 cc	not carried
Sodium Acetate (anhyd.)	10.0 grams	(S370)
Water to	1.0 liter	

To use: Dilute one part of concentrate with three parts water.

Concentrated Hardener

Water	500.0 cc	
Calgon	2.0 grams	(C150)
Sodium Carbonate (mono.)	92.0 grams	(S500)
Formalin (37%)	85.0 cc	not carried
Water to	1.0 liter	

Be certain to mix the hardener in the order given! If the carbonate is added to the formalin solution it may foam out and over the top of the container!

To use: dilute one part of concentrate with three parts of water.

Concentrated Bleach

Water	500.0 cc	
Potassium Ferricyanide	120.0 grams	(P580)
Potassium Bromide	60.0 grams	(P530)
Boric Acid	25.0 grams	(B350)
Borax ($10H_20$)	12.0 grams	(B301)
Water to	1.0 liter	

For the fixer I use a standard Rapid Fixer such as Kodak's. This is prepared as directed for black and white film.

Use film as follows:

When I expose my film I use a Wratten 85 filter over the lens when I am shooting outdoors. This requires that a speed index of 25 be used with type 5251 and an index of 50 with type 5254. Indoors, when I am using 3200°K lights I rate the film as 50 for type 5251 and 100 for type 5254 (no filter is required when using under 3200°K lighting).

Processing is carried out in the following manner:

(1) Prepare the developer per mixing directions. Then bring it to 75°f and develop for 11 minutes with continuous agitation. If this is potentially too difficult, then develop the film for 14 minutes, with agitation for five seconds each thirty seconds.

(2) Prepare the stop bath, hardener and bleach according to directions.

(3) After development, pour out the developer and pour in the stop bath. The time is for 4 minutes with intermittent agitation at 75°f.

(4) Pour out the stop bath and pour in the hardener. The time is for 4 minutes with intermittent agitation at 75°f.

(5) Pour out the hardener, and rinse the film for one minute in running water at 75°f. At this point (after the hardener), the room lights may be turned on. After rinsing the film for one minute, carefully unwind the film from the reel and with the ball of your thumb, rub off the carbon black backing under running water. Do not be afraid to run your fingers over the film. After the hardener treatment the emulsion is so tough that it is almost impossible to damage the emulsion. After the carbon backing has been washed off of the film, return it to the reel and continue washing for another three minutes.

(6) Pour off the wash water and pour in the bleach. The time is for 6 minutes at 75°f with intermittent agitation.

(7) Pour out the bleach and then wash the film for 4 minutes in running water at 75°f.

(8) Place the film in the rapid fixer for two minutes with continuous agitation. After this the film is washed for 6 or 7 minutes in running water, then treated in a Photo-Flo bath and hung up to dry.

Carefully cap and clean the bottles of concentrates. For my use I find that two ounces of each concentrate (stop-bath, hardener and bleach) when added to 6 ounces of water, will adequately fill my Nikor tank. Also, the concentrated solutions permit me to develop 16 rolls of 35mm film before they are to be replaced. There is no more trouble in mixing up the concentrates than there is in mixing up the actual working solutions.

If you are using Dignan's Color Print Paper, then the following filter pack is suggested for starters: .50 Magenta; .35 Yellow.

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24 FORMULAS YOU CAN MIX

From this basic "kit" of just six chemicals, you can mix literally dozens of developers.

By PATRICK DIGNAN

HAVE YOU ever longed to try one of the hundreds of b&w formulas recommended for this or that film or paper, but figured you didn't know enough about chemistry to mix your own? Most of these formulas are not available in packaged form . . . so you either mix them or forget them. Once you purchase an inexpensive set of weights and a scale or balance, a couple of graduates, and a few odds and ends like small picnic paper plates and plastic spoons, you are ready—except for the chemicals.

But before we discuss the chemicals you will need, let's look at a representative formula and make sure we understand all of the terms used.

The number of chemical terms used is not extensive. In fact, if you take the time to study a book of photo formulas, you will realize that there is a very definite and *simple* pattern which most formulas follow. Once you see

12 STANDARD FILM DEVELOPERS

	KODAK D-23	KODAK D-76	KODAK D-76R	KODAK D154	ANSCO 22	ANSCO 30	ANSCO 40	ADOX M-Q	ADOX REP.	AGFA 14	AGFA 15	GEVAERT G-251
METOL or ELON	7.5	2.0	3.0	1.25	0.8	3.5	4.5	2.0	3.0	4.5	8.0	1.5
SOD. SULFITE*	100.	100.	100.	22.5	40.0	60.0	54.0	80.0	80.0	8.5	125.	25.0
HYDROQUINONE	0	5.0	7.5	6.0	8.0	9.0	7.5	4.0	5.0	0	0	6.0
BORAX (Gran.)	0	2.0	20.0	0	0	0	0	4.0	18.0	0	0	0
SOD. CARBONATE#	0	0	0	35.0	50.0	40.	54.0	0	0	1.2	14.	45.0
POT. BROMIDE	0	0	0	.5	5.0	2.0	3.0	0.5	0	0.5	1.5	1.0
TIMES	10-12	9-17	—	2-3	5-8	6-8	4-5	10-19	—	10-20	7-12	2-3
DILUTION	0	0	0	0	0	0	1:2	0	0	0	0	0
	D-23 Medium fine grain dev. Increase dev. 10% per roll. Will process 8 to 10 rolls.	D-76 Use full strength for Tri-X. Dilute 1:1 for Plux X.	D-76 REPLENISHER: 30cc per 36 exp. roll of 35mm.	D-154 Contrasty document developer.	22 Title dev. High contrast.	30 X-ray for high contrast.	40 Tray dev. for pack, roll, and cut film.	Adox M-Q Slightly better sharpness than D-76.	Adox Replenisher: add 10 to 25cc per 36 exp roll of 35mm.	Agfa 14 Soft working dev. similar to D-23.	Afga 15 For slow & medium speed films.	Gevaert G-251. Universal type dev. For films & papers.

Times given in minutes, minimum-maximum range, for use at 68°F. Total formula solution in each case, 1000cc. Start with 500cc of water at 125°F. Add chemicals in order given. Dissolve each chemical completely before adding the next one. Dilution: where 0 is listed, use straight; otherwise, first figure is stock solution, second figure equals part(s) water. *Sodium Sulfite (Anh. of Des.) #Sodium Carbonate, Monohydrate

this pattern, all the formulas simplify themselves. This applies to past, present, and future formulas.

D-76 is available in packaged form, but is an old standby so we will use it as an example.

Elon-Hydroquinone Borax Developer For low Contrast and Maximum Shadow Detail:

Water (125°F or 52°C)	24 ounces	750 cc
Elon	29 grains	2.0 grams
Kodak Sodium Sulfite, desiccated 3 oz.	145 grains	100.0 grams
Kodak Hydroquinone	73 grains	5.0 grams
Kodak Borax, granular	29 grains	2.0 grams
Add cold water to make	32 ounces	1.0 liter

The Pattern—Most formulas give you a choice of two systems of measurement, as you will note above in D-76. One is U.S. Avoirdupois, which is measured in the familiar gallons, quarts, pints, ounces, and grains. We suggest that you ignore this part of the formula and move over to the metric system.

There are a number of good reasons for using the metric system, but the main one is that it simplifies mixing. By using it you can save time. It is also used internationally and is based on the *meter*. A meter is approximately 39.37 inches. This is too large an amount to use for measuring solutions so we use the *cubic centimeter,* which is 1/100th of a meter cubed.

Most formulas are compounded to make one liter (or as the British write it, "Litre"). This will make no sense until you realize that a liter is equal to 1000 cubic centimeters. We should say photographically equal. The difference is that a liter is 1000.028 cubic centimeters. We know of no formula where the difference will upset the solution, and by that we do not mean tip it over. A cubic centimeter is abbreviated cc.

A *milliliter* is 1/1000th of a liter, and is equal to one cubic centimeter, or one cc. Milliliter is abbreviated ml. You will find ml and cc used in formulas, and you will find cc used with liter. The thing to remember is: When you see ml, think cc; and when you see liter (or litre), think 1000 cc.

All of the above measurements are used for liquids *only*. Whether water or a liquid chemical like acetic acid—you are measuring volume.

The *gram* is basic to the metric system. The term gram designates the amount of pure water it takes to fill one cubic centimeter at 4°C (or approximately 39.2°F). The gram and the cc are two measurements that make mixing solutions very simple. Take one gram of any chemical and add water until you have 100 cc., and you have a 1% solution. This comes in handy when you need a chemical in very small amounts, and your scales are not very accurate. However, even an inexpensive scale should be accurate to at least one gram.

The *milligram* is used like milliliter to denote amounts less than one gram: for instance, 200 milligrams is 2/10th of a gram. The gram also denotes in most cases that you are weighing a solid.

Most formulas give you a choice of two ways to measure *temperature,* Centigrade and Fahrenheit. If you happen to own a thermometer that is calibrated in Centigrade, use it. However, thermometers calibrated in the Fahrenheit scale are more commonly

12 STANDARD PAPER DEVELOPERS

	KODAK D72	KODAK D163	KODAK D-52	KODAK D154	ANSCO 120	ANSCO 135	AGFA 100	DUPONT 51D	DUPONT 54D	DUPONT 56D	ILFORD ID-20	GEVAERT G251
METOL or ELON	3.0	2.2	1.5	1.25	12.3	1.6	1.0	1.5	2.7	3.3	1.5	1.5
SOD. SULFITE*	45.0	75.0	22.5	22.5	36.0	24.0	13.0	22.5	40.0	33.5	25.0	25.0
HYDROQUINONE	12.0	17.0	6.0	6.0	0	6.6	3.0	6.3	10.6	10.0	8.0	6.0
BORAX (Gran.)	0	0	0	0	0	0	0	0	0	0	0	0
SOD. CARBONATE#	80.0	75.0	17.0	35.0	42.0	24.0	30.0	17.5	87.0	65.0	35.0	45.0
POT. BROMIDE	2.0	2.8	1.5	0.5	1.8	2.8	1.0	1.5	0.8	3.3	2.0	1.0
TIMES	1	1½-2	2	1-1½	1½-3	1½-2	1-2	1½-2	1½-2½	1-2	1½	1-2½
DILUTION	1:1	1:3	1:1	0	1:2	1:1	0	1:1	1:2	1:2	1:1	0
	D72 (Dektol) For Velox-Azo-Y Resisto-Velox Rapid etc.	D163 Enlarging dev. Warm black tones on Chloro-Bromide.	D52 (Selectol) Warm tones on Opal-Athena-Platino, etc.	D154 Contrasty document dev.	120 Soft working developer portrait type.	135 General type dev. for warm tones.	AGFA 100 For normal contrast.	Dupont 51D For warm black tones.	Dupont 54D For cold blue black tones on Chloride.	Dupont 56D Rapid dev. for Velour Black, Varigam, etc.	Ilford ID-20 General type for Multigrade, Plastika, etc.	Gevaert G251 Universal dev. for film & paper.

Times given in minutes, minimum-maximum range, for use at 68°F. Total formula solution in each case, 1000cc. Start with 500cc of water at 125°F. Add chemicals in order given. Dissolve each chemical completely before adding the next one. Dilution: where 0 is listed, use straight; otherwise, first figure is stock solution, second figure equals part(s) of water. *Sodium Sulfite (Anh. or Des.) #Sodium Carbonate, Monohydrate

available. The choice is up to you. I, personally, think and feel in Fahrenheit.

Another part of the pattern you should note is that most of the formulas recommend using *warm* water (125° F) to start with. The reason: heat speeds up most chemical reactions, and most chemicals dissolve faster in warm water. But use *the* temperature recommended. Water that's too hot will destroy some chemicals.

Most formulas start with *less* water than the final solution amount (1000 cc). The reason is simple enough: if you start with 1000 cc and add chemicals, you may end up with a total volume much larger than 1000 cc.

A rule that is not always written in the formula, but which *must* be followed, is: "Dissolve each chemical COMPLETELY in the order given . . . before the next chemical is added." The reason for this is that although most chemicals look alike (the majority are white powders or crystals), they each have a very definite personality all their own. Some refuse to dissolve after another chemical has been added. Some are helpers, such as preventing oxidation of a chemical that is to be added later. Add each chemical slowly, stirring the solution so that the chemical will go quickly and completely into solution.

When you decide to compound your own solutions, *contamination* takes on new meaning and importance. Besides keeping all the utensils clean, it also means preventing one basic chemical from getting, even slightly, mixed with another basic chemical. A few good working rules will solve this. *Rule 1:* Open only one bottle at a time, and weigh out the amount that you will use. Make sure you return the same cap to the same bottle. This rule should be easy, because you should be following this one if you are using bottled developers, fixers, etc. *Rule 2:* Make sure that the spoon you use is clean. We suggest you use inexpensive plastic picnic spoons. A package of 100 costs less than 50¢. If these are kept in a closed container within easy reach, a clean one can be used *each* time you weigh out a different chemical. *Rule 3:* Always use a clean piece of weighing paper on your scale for each chemical. If you do not, you may end up with contamination if you weigh out more than you need and then try to remove some of the chemical from the weighing pan and return it to its original container. The trouble we have found with using prepared weighing paper is that it is never big enough to hold the larger amounts of some chemicals. We have found that small paper plates can be used for holding these larger amounts. Make certain that you place one plate on each side of the scale and zero the scale before you add the weights or the chemicals. When you zero your scale, check the table it's on and make sure that it is level. If not, all of your weighing will be wrong.

We can now go back and write D-76 in our new shorthand, leaving out all of the things we are going to remember, plus all of the items we will not need. It will simply look like this:

D-76 DEVELOPER

Elon	2.0 grams
Sodium Sulfite (des.)	100.0 grams
Hydroquinone	5.0 grams
Borax (granular)	2.0 grams
Water to make	1.0 liter

If you purchase a ready to use can of developer (which is usually in at least two parts) and mix it according to directions, how much longer will it take to mix the above formula? Once you have a corner set up with a balance, weights and the chemicals, *only a few more minutes.*

Since we are discussing D-76, let's take each of the chemicals used and discuss some of the problems that can plague you:

- *Elon*—This is Kodak's trademark for a developing agent. The chemical name is "p-Methyl-amino-phenol Sulfate." This developing agent has been around for many years, and it has collected many trade names which just add to the confusion. Here are a few: Metol, Photol, Rhodol, Veritol, Claritol.

We mentioned earlier that you should dissolve chemicals in the order given. Elon is a very good example of why. It will refuse to dissolve in a strong solution of Sodium Sulfite. Elon is almost always used in small gram quantities, usually one to four grams. This, too, is a part of the formula pattern. A pound of this chemical will last a year or so, if you mix a gallon or two a week.

- *Sodium Sulfite*—This is one of the chemicals that has made photography as we know it today possible. It prevents oxidation of the developing agent or agents. Without it, we would be faced with mixing fresh solutions every few minutes. If you would like to see a developing agent oxidize, let a solution of Elon stand after mixing without this chemical. The solution will slowly turn brown, and eventually black. However, if after it has turned slightly brown (a minute or two after mixing) you add Sodium Sulfite, the solution will immediately revert back to a clear solution.

Sodium Sulfite is used in thousands of b&w and color developers, fixers, toners, hardeners, etc. Most formulas call for relatively large amounts, but it can run from one gram to over 100. Fortunately, it is inexpensive, and I suggest you purchase five or 10 lbs. at a time.

There are, incidentally, three words, any one of which may appear after a chemical, that can confuse not only new experimentors, but old hands, as well. When you see one of the following words, realize that it means something that you should know about *before* you start to mix your own formula. They are DESICCATED, ANHYDROUS, and CRYSTAL. Sodium Sulfite, for instance, is manufactured in more than one form, and the differences between these forms are very important, since they are all part of the world of *water of crystallization.* Here are the chemical formulas for the two types of Sodium Sulfite available: Na_2SO_3, $Na_2SO_3 \cdot 7H_2O$. That's right, it's the same stuff you've been drinking—water.

A processing formula is poorly written if it only lists Sodium Sulfite, because you will not know what type of Sodium Sulfite the formula calls for. If you look up desiccated, you will find that it means "with as much water removed as possible." If you look up anhydrous, you will find that it means "without water". Photographically, these two words can be used interchangeably in a formula. When you purchase Sodium Sulfite here in the U.S., the chances are you will be buying Sodium Sulfite, Anhydrous (or Desiccated), but *check the label.* If the label reads *Crystal,* this could mean that they are referring to $Na_2SO_3 \cdot 7H_2O$. Converting from one to the other form with this chemical is very easy, because Sodium Sulfite Crystal weighs approximately twice as much as Sodium Sulfite Anh. The

difference in weight is *only* water.

To put it another way, let's say the formula calls for Sodium Sulfite, Crystal . . . 200.0 grams. You have purchased Sodium Sulfite Anhydrous. Instead of using 200.0 grams, use 100.0 grams . . . and you will be using the correct amount of Sodium Sulfite. Most processing formulas published in the U.S. list Sodium Sulfite, Anhydrous or Desiccated, but you never know when you'll come across an old formula that reads Crystal. (Water of hydration, incidentally, also applies to a number of other photographic chemicals.)

Learning the difference between the spelling of the various words used in photo chemistry is not only important, it is mandatory. The problem is slightly complicated and confusing. We will discuss here only Sodium Sulfite. Older literature will spell it Sodium Sulphite. These two spellings refer to the same chemical. But, again, take care. You will also run into Sodium Sulfate or Sodium Sulphate. These two refer to the same chemical, but are entirely different from Sodium Sulfite. A few more chemicals in this group should also be watched. One pair is Sodium Bisulfite and Sodium Metabisulfite. These are not the same chemical, although with some changes in a formula they can replace Sodium Sulfite.

- *Hydroquinone*—The chemical name for this is p-hydroxybenzene. It is known by trade names, but for some strange reason most formulas will refer only to Hydroquinone. How lucky can we get! There are hundreds of formulas that use Hydroquinone in conjunction with Elon. The two are said to be super-additive. That is, development is much greater using the two than the development potential of either agent alone. This chemical should not give you problems; it keeps well, although it should be protected from strong sunlight.
- *Borax*—This is usually referred to as "Borax, Granular", but is also known by a number of other names: Sodium borate, Sodium pyroborate, Sodium tetraborate, etc. Again, make sure you know your chemical. If in doubt, any school or Public Library contains a number of chemical dictionaries . . . use them. Borax, granular, refers to Borax $Na_2BO_{47}{\cdot}10H_2O$. Yes, we are back to the water. This is the form usually called for if the formula reads *Borax*. This is the mild alkaline used in D-76 and any number of other formulas. Keep this bottle closed, or this chemical will give up its water to the air, which will throw off your weighing.

Borax, Anhydrous, has become available in the last few years and, like Sodium Sulfite, the Borax crystal is approximately 50% water, so if you should get Borax, Anhydrous, use 50% less. Perhaps you have started to wonder just why some chemicals contain water and some do not. Some of the reasons are caused by manufacturing problems. It is cheaper to leave the water in. Some chemicals absorb the water from the air, and some give up their water. Chemicals, like people, are all different—and some are even difficult.

Plus Two More

We said earlier that with six chemicals you can mix dozens of formulas, and we plan to keep our word. Let's take a different formula, Gevaert G 251. It contains the following (using our shorthand):

Elon	1.5 grams
Sodium Sulfite (des.)	25.0 grams
Hydroquinone	6.0 grams
Sodium Carbonate (MonoHydrate)	45.0 grams
Potassium Bromide	1.0 grams
Water to Make	1.0 liter

In addition to the chemicals already mentioned, this formula also contains:

- *Potassium Bromide* — Potassium Bromide is available as colorless crystals, or white granules or powder. However, there is no water in this one, so we do not have a hydration problem. Following our pattern, this chemical is used mostly as a restrainer in developers (both film and paper). The amount used varies from 0.5 grams to 5.0 grams, so a little of this chemical will go a long way.
- *Sodium Carbonate Monohydrate*—Yes, you guessed it, water of hydration again. In this case, the formula reads $Na_2CO_3{\cdot}H_2O$. Mono means one, hydration means water—thus, one water. Most U.S. formulas will refer to Sodium Carbonate monohydrate. The English seem to prefer the Anhydrous. The only problem you will encounter here is when you try to use formulas from British magazines or books. This chemical is more alkaline than Borax. In other words, it will increase the pH.

Except for the formulas, that's about it. So go back to the opening pages of this story where you'll find a small group of standard formulas, published by the various manufacturers of film and papers, to get you started and to show you that there is very little difference between the various ones offered. From here the whole world of mixing your own is open to you. Add an additional chemical or two, for instance, and you'll have dozens more to choose from.

It does take a small investment, but to our way of thinking there's a BIG return, with the added pleasure of being able to say, "I did it all myself!"

GUIDE TO COLOR PRINTING—

Ed: The following is from a booklet called "Gevacolor" which was published in 1964 by Agfa Gevaert.

Regardless of the type of paper used, whether it be Ektacolor, Agfacolor, Dignan Color Print Paper, etc., we think it explains and solves many of the problems that the photographer encounters when he makes the switch from black & white to color.

GENERAL PRINCIPLES

The better the negative, the better the print that can be obtained from it. This well-known maxim of black & white photography applies with even more force to color. Four, five or sometimes even as many as six grades of paper are available for the correction of less successful black & white negatives. Color printing paper is only available in one grade, so that the quality of negatives is of capital importance. It is therefore recommended only to make color prints from good quality negatives. From less successful negatives it will generally be possible to obtain black & white prints. This however, gives rise to supplementary costs and work.

Darkroom Illumination

As Gevacolor positive material is least sensitive to the region of the spectrum corresponding to the principal emission of sodium lamps, these lamps are recommended for the illumination of laboratories handling positive material. A Gevinac D2 safelight screen has to be used to still further reduce the actinic power of this kind of light.

Ordinary, incandescent bulbs may be used, provided they are screened by a Gevinac X592 or a Gevalor X591 filter. *

The intensity of the lamp must be such that the paper is not fogged after an exposure as long as the duration of normal processing.

It is not enough to test the darkroom illuminations only with regard to fogging. For imperfect illumination can cause a shift of the image color towards cyan, without any fogging of the paper.

The best method to secure a perfectly safe darkroom illumination is the following: print a few sheets of Gevacolor paper through a color negative in the usual way; half of each sheet is then exposed to the darkroom illumination. If after development the part of the prints not covered show a more pronounced cyan aspect than the covered half, the darkroom illumination is too strong and unsafe.

*Ed: You can also use a Kodak Wratten series 10 with 10 or 15 watt bulb.

Printers and enlargers

Apparatus for the production of paper color prints and enlargements must fulfill certain special requirements.

Filter Holder - Printers and enlargers must be provided with a device enabling the entire beam of light to be intercepted by correction filters. In the case of an enlarger such filters are placed between the light source and the condenser.

Printers and enlargers must therefore be fitted with filter holders. Most models of recent make are so equipped.

One can also place the filters under the lens, but this can only be done when gelatine sheet filters are used.

Lamps - Should opal bulbs be used or not? The answer to this question will depend on the type of apparatus that it is intended to use. The decisive consideration here is to obtain an even illumination.

It is advisable to run the lamps at 5% to 10% below their rated voltage. This will both increase their life and help to maintain a constant color temperature. Fluorescent lamps are not suited as light sources.

Voltage Control - Fluctuations in the electrical supply cause considerable changes in the spectral composition of the light. It is therefore necessary to compensate such fluctuations by means of automatic voltage control mechanism (Stabilovolt). Failing this, a voltmeter can be used in conjunction with a variable rheostat.

Optical Equipment - To ensure best possible definition, lenses fitted to enlargers should be fully color corrected.

Exposure Timer - It is also very important to be able to regulate the exposure within narrow limits. Printers and enlargers must therefore be equipped with accurate timers permitting setting of exposure to within 1/10 second. *

*Ed: We think the above tolerance of 1/10 of a second is a little high. One second intervals available on Gra-Lab timers or on Time-O-Lite are more than adequate for any type of color printing.

Color Balance - Color Casts

To make a good print in black and white photography it is necessary to determine the correct paper grade and exposure for each negative. In color photography a further factor, color balance, has also to be considered.

Correct color balance cannot be obtained automatically, as it is affected in its turn by various factors:

- Slight differences between the different batch numbers;
- Age of the emulsions:
- Composition (color temperature) of the light at the time of the exposure;
- Under- or over-exposure of the negative;
- Color characteristics of the lenses of camera and printer/ enlarger;
- Development

Any variation in one of these factors may disturb the entire rendering and cause a color cast over the image.

This color cast is caused by over- or underexposure of one or two of the layers of the positive relative to the remaining ones.

If only one layer is affected, the case will be simple: either yellow, magenta or cyan. But if two layers are affected, a composite cast will result, i.e.: blue (magenta + cyan), green (yellow + cyan) or red (yellow + magenta).

Note that the two components of a composite cast are almost never of equal intensity.

Examination of Test Prints

Some little practice is needed before it is possible to identify the exact shade and intensity of a color cast. In larger processing stations it is advisable to entrust the examination of test prints to the same person, so that they can become expert at such work. This will serve to avoid noticeable fluctuations in the quality of prints. It is a well known fact that people vary in their judgment of colors.

Prints on paper should be examined in daylight but away from direct sunlight, as it is in these conditions that the customer will usually view them. If sufficiently strong daylight is not available, daylight type lamps may be used, either alone or in conjunction with daylight.

In order that the eye may accustom itself to the recommended illumination, there must be no other kind of lighting in the rooms where prints are examined. The light must be sufficiently powerful to enable the darkest parts of the prints to be examined with ease.

Positives on Gevacolor Copyfilm should be examined in front of a light source identical to the one in front of which they will be mounted or exhibited.

METHODS OF CORRECTION

Color casts may be corrected by two distinctive methods - one subtractive and the other additive.

The subtractive method uses one single source of light of which the spectral composition is modified by means of special correction filters, which absorb part of the printing light.

In the additive method, use is made of three different sources of light. With the aid of filters, three beams of colored light are obtained: blue, green and red. These are used in printing one after the other, or combined. Their respective light intensity is adjustable.

A - THE SUBTRACTIVE CORRECTION METHOD

Gevacolor CC Filters

Gevacolor CC filters are the special correction filters, designed to eliminate color casts in the subtractive production of color positives on paper or film. The filters must not be confused with Gevacolor CT filters which are designed to compensate for variations in the color temperature of the illumination by which the negative was exposed.

Gevacolor CC filters are supplied in the same basic colors as those which are formed in the three emulsion layers of color films, i.e.:

y = yellow

m = magenta (purple)

c = cyan (blue-green)

For each color there is a series of 11 filters: 10 densities numbered from 10 to 100 in steps of 10, and one of 5 in order to form the intermediate densities. These 3 series together form the Set of 33.*

*Ed: Although all manufacturers calibrate their color printing filters the same, they do vary as to the number of filters and how low or how high a density is included in the set. Ansco filters only go to 50, however, on the low end they go down to a .025.

Sets of 33 filters are available in two forms:

1. in gelatine sheets
2. in gelatine coated on glass, the gelatine side being protected by a second glass.

Sets of 33 filters are supplied in the following sizes:

2 3/4 x 2 3/4 inches (7x7 cm), 4 3/4 x 4 3/4 inches (12x12 cm), and 5 x 7 inches (13x18 cm), 6 5/16 x 6 5/16 (16x16 cm) the latter only available in gelatine coated on glass. Gevacolor CC filters are not supplied cemented between sheets of optically flat glass.

Designation of Gevacolor CC Filters

It is convenient for practical purposes to have a uniform designation for filter combinations. The number indicating the filter combination is made up of three groups of figures indicating the colors in the following order:

y (yellow) - m (magenta) - c (cyan)

Thus yellow filter y of density 30 is indicated as follows: 30 — —; magenta filter m of density 50 will be indicated as follows: — 50 —.

Results obtained from Gevacolor CC filters are proportional to their density number. Thus filter No 40 + No 30 of the same color will have the same effect as a single filter 70 (loss of light caused by surface reflections on the glass being ignored). This designation system enables a record to be kept of filters used during a given operation by simply making a note of the numbers (e.g. on the back of the print). Thus the figures 40 — 70 indicates that a filter y40 and a filter c70 were used.

Computing filter numbers

a) Addition

Two filter combinations may also be added together.

Example:

$$\begin{array}{r} 20\ —\ 30 \\ +\ 25\ 15\ — \\ \hline 45\ 15\ 30 \end{array}$$

The result will often be a combination of three filters.

However, three filters of different color but equal density used in conjunction, produce a neutral grey which serves only to reduce the intensity of the printing light without changing its its color composition. It is therefore useless to employ more than two colors in the filter combination.

b) Simplification Rule

To reduce a three-filter combination to two filters, subtract the smallest number of the combination from all three numbers.

Example: The sum quoted above gave the combination 45 15 30. It is thus possible to subtract 15 units from each part, with the result that the combination now reads 30 — 15.

c) Subtraction

The need to subtract one filter combination (B) from another (A) may also arise.

1. If all components of (A) are larger than the components of (B), no difficulty whatever arises.

Example:	Combination (A):	30 — 15
	Combination (B):	- 10 — 5
	New Combination:	20 — 10

2. It may happen that one or both of the numbers of the combination (B) to be subtracted are larger than those of the initial combination (A). In this case, a same figure should be added to the three components of the combination (A), so that the numbers of combination (B) can be subtracted from the components of combination (A). This is in accordance with the principle stated above whereby the use of three filters of different color but equal density gives a neutral grey. To make subtraction possible, the same number can be added to the three components of a combination, since this will not change the color composition.

Example:	Combination (A):	30 — 15
	Subtract combination (B):	- 10 — 25

As 25 cannot be subtracted from 15, the difference of 10 is first added to the three components of the initial combination, then subtraction is possible, thus:

	40 10 25
	- 10 — 25
New combination:	30 10 —

Basic correction

On each packet of color paper is given a correction figure: e.g. 30 — 15. This correction value has been established at the factory under standardized conditions by making a neutral-grey print of a neutral sensitometric step-wedge on the paper in question; in the present example, the required combination of filters will be : 30 — 15.

We must however, point out that this basic correction has not an absolute value; its main purpose is to reduce the number of tedious tests which are necessary when proceeding from paper of one batch number to that of another and to serve as an initial correction for the new paper. On the basis of this correction, the procedure should be as follows:

Let us assume that a good print was made on the old paper with a filter combination 20 30 — the basic correction for the new paper is 10 — 25, while that of the old paper was 30 — 15.

First, the initial correction of the old paper (combination A = 30 — 15) is subtracted from that of the new paper (combination B = 10 — 25).
The result is:

combination (B)	10 — 25 or	30 20 45
combination (A)	- 30 — 15	- 30 — 15
		— 20 30

This difference is added to the final correction of the old paper (found to give a good quality print):

	20 30 —	
Total correction for the	+ — 20 30	
new paper:	20 50 30 or	— 30 10

The technique of the color correction

Gevacolor CC filters absorb light of their own complementary color.

Thus a yellow filter absorbs blue light
a magenta filter absorbs green light
a cyan filter absorbs red light.

As a matter of fact the degree of absorption depends on the density of the filter.

The three emulsion layers of Gevacolor films and paper are sensitive to blue, green and red light. To influence their sensitivity, yellow, magenta and cyan filters are required respectively.

Example: When using a magenta filter, this will absorb part of the green rays in the printing light, and should at least in theory, permit the other rays to pass freely (Fig. 1).

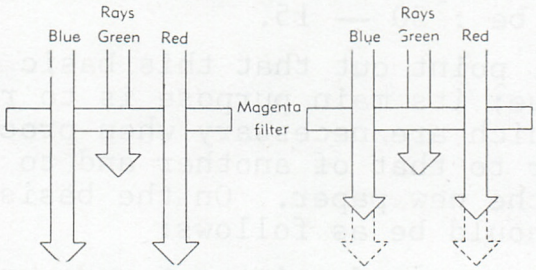

Fig. 1 Fig. 2

Such results are however not obtained in actual practice, as in fact the magenta filter also absorbs a small amount of the other rays (Fig. 2). This must be borne in mind when making accurate exposure calculations.

Let us now apply these principles to the printing of color positives. The diagrams illustrating the present description (Fig. 3, 4 and 5) show the three sensitive layers of positive material. The first or upper layer is sensitive to blue and forms a yellow image (y); the second layer is green-sensitive and forms a magenta image (m); the third is red-sensitive and forms a cyan image (c). The white printing light (represented by arrows), is in fact made up of blue (B), green (G) and red (R) rays which, if available in the correct proportions will produce a normal image on the sensitive layers of the print (Fig. 3).

Let us suppose that the density of the magenta partial image of the negative is insufficient. It will not hold back the green rays from the printing light sufficiently, and these, being too intense, will unduly affect the green-sensitive layer of the positive. In development an excess of magenta will then be formed (Fig. 4).

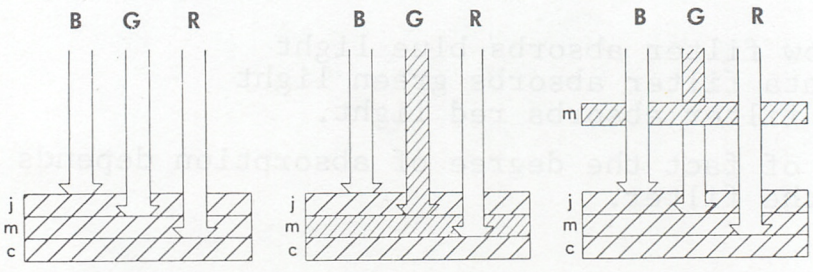

Fig. 3 Fig. 4 Fig. 5

In order to absorb this excess of green light, a magenta filter must be used, i.e. a filter of the same color as the color cast (see Fig. 5). The density of the filter must be proportional to the cast.

NOTE: In the example cited the fault was in the negative. This is however not the only possible cause of a color cast. For instance, there may be a slight variation in the sensitivity of one of the emulsion layers of the positive which will also produce a color cast.

Whatever the reason (see p. 384), it will always cause over-exposure of one or two of the emulsion layers of the paper. This color cast is corrected by varying the color composition of the printing light with the aid of Gevacolor CC filters.

The same is true for the composite color casts: blue, green and red. These casts are caused by over-exposure of two emulsion layers. As we have seen above, such a color cast is eliminated by using a Gevacolor CC filter of the same color as the color cast; therefore, the correction of the composite cast, would necessitate a blue, green or red correction filter. But as the range of Gevacolor CC filters does not include filters of these colors, they must be made up by combining two filters:

for blue: use magenta + cyan
for green: use yellow + cyan
for red: use magenta + yellow

For example, should a print show a green cast, the required green filter is obtained by combining a yellow and a cyan Gevacolor CC filter (see Fig. 6 and 7).

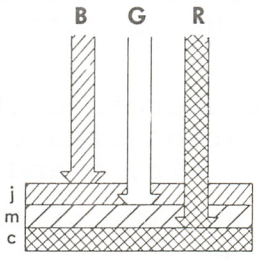

Fig. 6

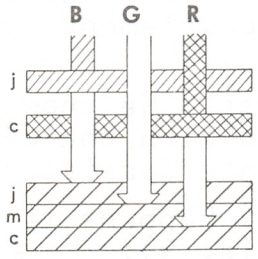

Fig. 7

It should be noted that the two component colors of a blue, green or red cast do not necessarily have equal intensity values. It will therefore, necessitate the use of two filters of different densities (different filter numbers) to eliminate such a color cast.

For instance, a red cast (consisting of magenta and yellow) may contain more magenta than yellow. This cast can be removed by using magenta and yellow filters of different densities. The density (and therefore, the number) of the magenta filter must be higher than that of the yellow filter.

Over-correction

Correction can be overdone. We should distinguish between two possibilities: simple color casts and composite color casts.

Simple color cast. As we have seen above, a magenta cast is eliminated by the use of a magenta filter of the required density.

Let us assume that a too strong magenta Gevacolor CC filter has been chosen to adjust the color balance (see Fig. 8). In this case, the filter will absorb too much green light from the printing light with the result that the green-sensitive layer will be under-exposed and that consequently during color development too little magenta will be formed in this layer.

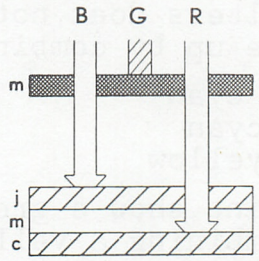

Fig. 8

The yellow and cyan densities will then be excessive resulting in a green cast, the complementary of the magenta cast we set out to remove.

Composite color cast. We know that a green cast in a positive print is eliminated with the combination of a cyan and a yellow filter of appropriate densities (see Fig. 6 and 7).

Let us now see what happens if the density of one of these filters is too high (see Fig. 9).

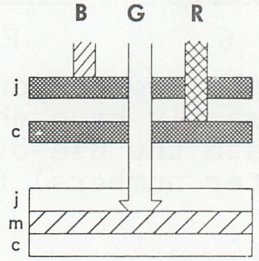

Fig. 9

In this case, the cyan and yellow filters absorb respectively too much red and too much blue light, resulting in under-exposure of the red and blue sensitive layers. Color development will then produce respectively too little cyan and yellow in these layers.

The print will show a too strong density of magenta, in other words a magenta cast or the complementary of the green cast which had to be eliminated.

Rules for the subtractive correction method

From what goes before the rules of color correction may be deduced:

Rule I: To eliminate a color cast, use a filter of the same color as the cast itself.

Rule II: The density of the filter must be in direct proportion to that of the cast to be eliminated.

Remark: Over-correction causes a fresh cast, whose color is complementary to the original one.

Examples:

1. A print made with filter correction

— — 25

cyan has a magenta cast. In this case it will be necessary to add a magenta filter of the appropriate density, say — 20 —. The filter combination will now become

— 20 25

2. A print made with filter combination

20 10 —

is too yellow.

This cast can be corrected with a yellow filter. But as the filter combination already includes a yellow filter, all that is necessary is to select one of higher density. The print will now be made for example, with the combination

30 10 —

3. A print made with the filter combination

30 50 —

is to cyan.

According to Rule 1 a filter of the same color as the cast must be added: e.g.

— — 10

This gives the following correction:

30 50 10

or after applying the simplification rule (p. 387):

20 40 —

The correction is thus simplified to a decrease in density of the yellow and magenta filters.

4. A print made with filter combination

10 20 —

is too red. As red is obtained by combining yellow and magenta, the red cast can be corrected by adding a yellow and a magenta filter to the combination in use. The addition, for example, of a yellow filter 10 — — and a magenta filter — 10 — will give:

10 20 —
+ 10 10 —
= 20 30 —

5. A print made with a yellow filter

30 — —

is too blue.

According to Rule 1, a filter or filter combination of the same color as the cast must be added. As the print is too blue (magenta + cyan), a magenta and a cyan filter must be added to the existing combination. By the addition, for example, of magenta — 10 — and cyan — — 10, the following filter combination will be arrived at:

30 10 10

or after applying the simplification rule (p. 387):

20 — —

6. A print made with filter combination

15 25 —

shows a green cast.

This cast, a combination of cyan and yellow, can be corrected by adding a cyan and a yellow filter to the combination used. If, for example, a yellow 10 — — and a cyan — — 10 filter are added, the new combination will be:

15 25 —
+ 10 — 10
= 25 25 10

or simplified:

15 15 —

All that is necessary in this case is to reduce the density of the magenta filter (from 25 to 15) which is the complementary color of the green cast.

Ed: We will cover additive color printing in a future issue of the Newsletter.

Exposure calculation

The correct exposure for a color print or enlargement is established in the same way as in black-and-white photography: i.e. by means of test strips, each strip receiving longer exposure than the last. But a better method is to determine the exposure with a special exposure meter.

Filter factors

As magenta and cyan Gevacolor CC filters contain a certain amount of grey, they stop not only their normal selective absorption but also a certain part of the white printing light. The result is that during printing or enlarging of color negatives, if the density of a magenta or cyan filter is increased or decreased, the initial exposure must be increased or decreased by 10 per cent for each 10 units difference in filter density. This rule is only valid for small differences in density of the filters used.

Yellow filters do not need any correction in exposure.

Notes

1) It should be noted that as a result of the change in the exposure-time the correction to be applied may vary according to the sizes to which a negative is enlarged.

It is therefore advisable not to vary the size in the course of the correction operations.

If enlargements of different sizes are required from the same negative, it is better to leave the exposure-time unaltered and to vary the diaphragm, as far as possible. This will make it unnecessary to find a new correction.

2) In the subtractive method, the exposure cannot be modified by varying the intensity of the light. This involves a change in its color (color temperature) and thus would entail a new correction.